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(54) **TRACTION WINCH**

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B66D 1/22 (2006.01)

(52) **U.S. Cl.** **254/297**; 254/278

(58) **Field of Classification Search** 254/278, 254/293, 294, 295, 297, 316, 342, 344
See application file for complete search history.

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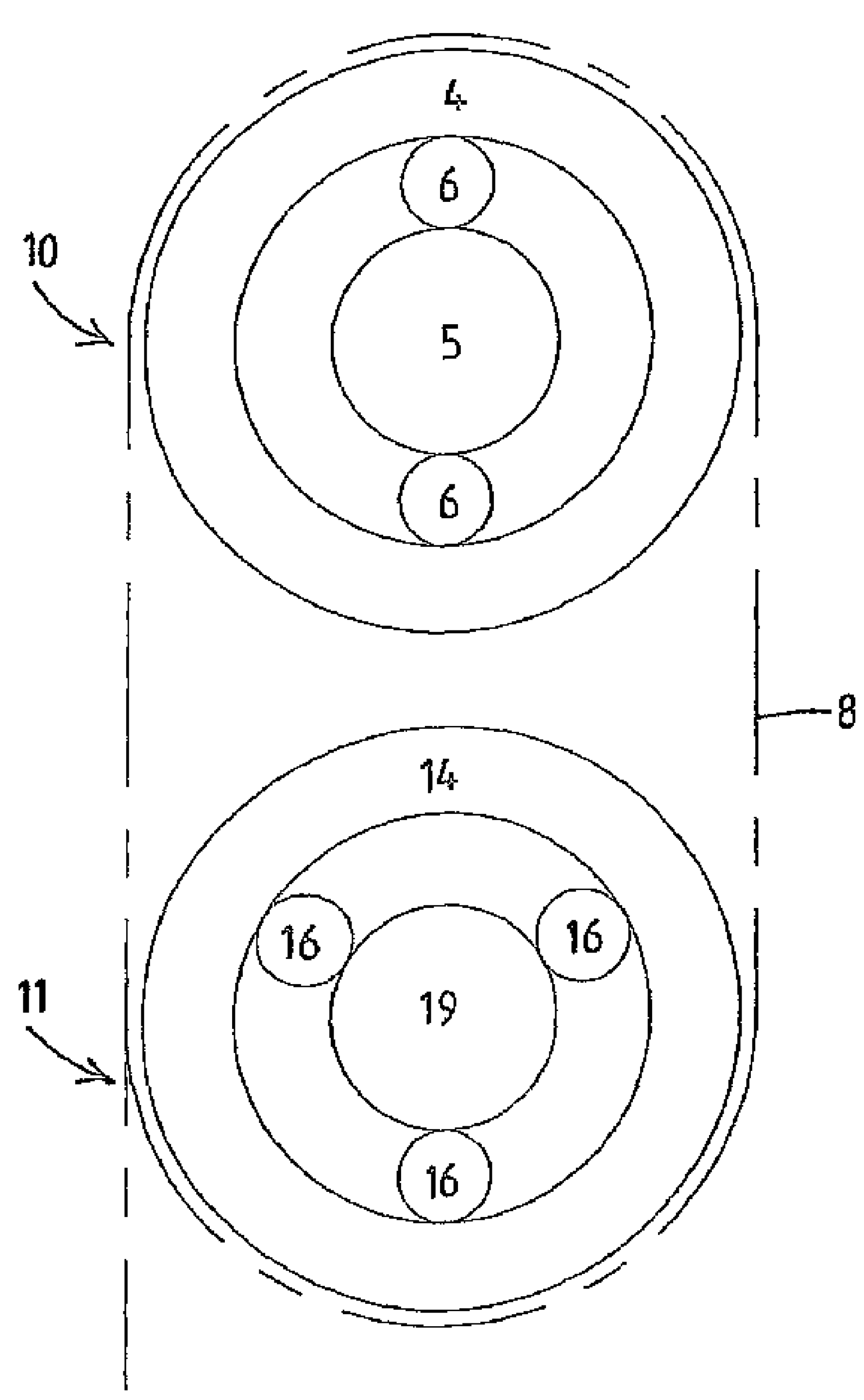
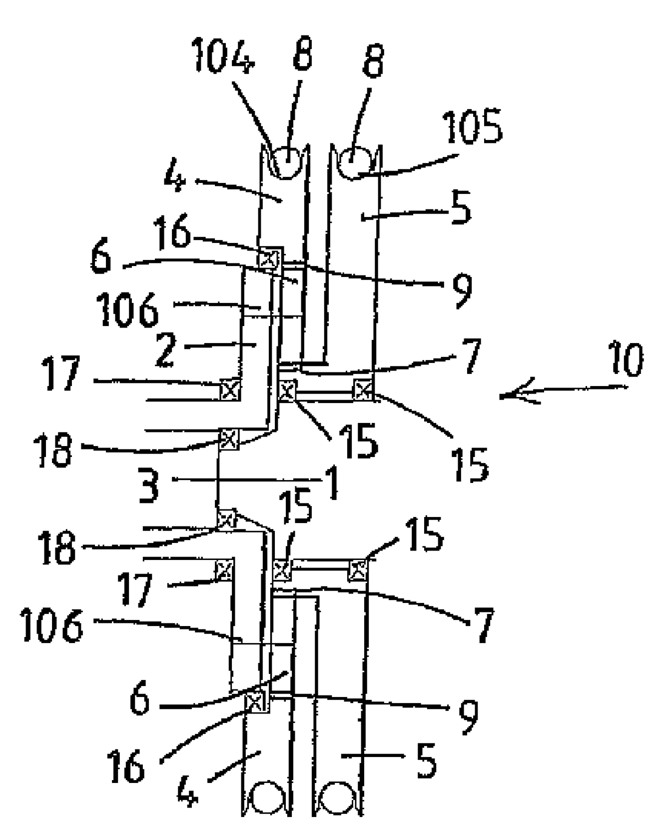
(57) **ABSTRACT**

A traction winch for a cable or the like includes a winch frame, at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable. The winch further includes at least two rotatable driveshafts, journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly, and at least one motor for driving the driveshafts. The winch includes a differential assembly being provided between each driveshaft and sheave assembly so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation.

19 Claims, 5 Drawing Sheets





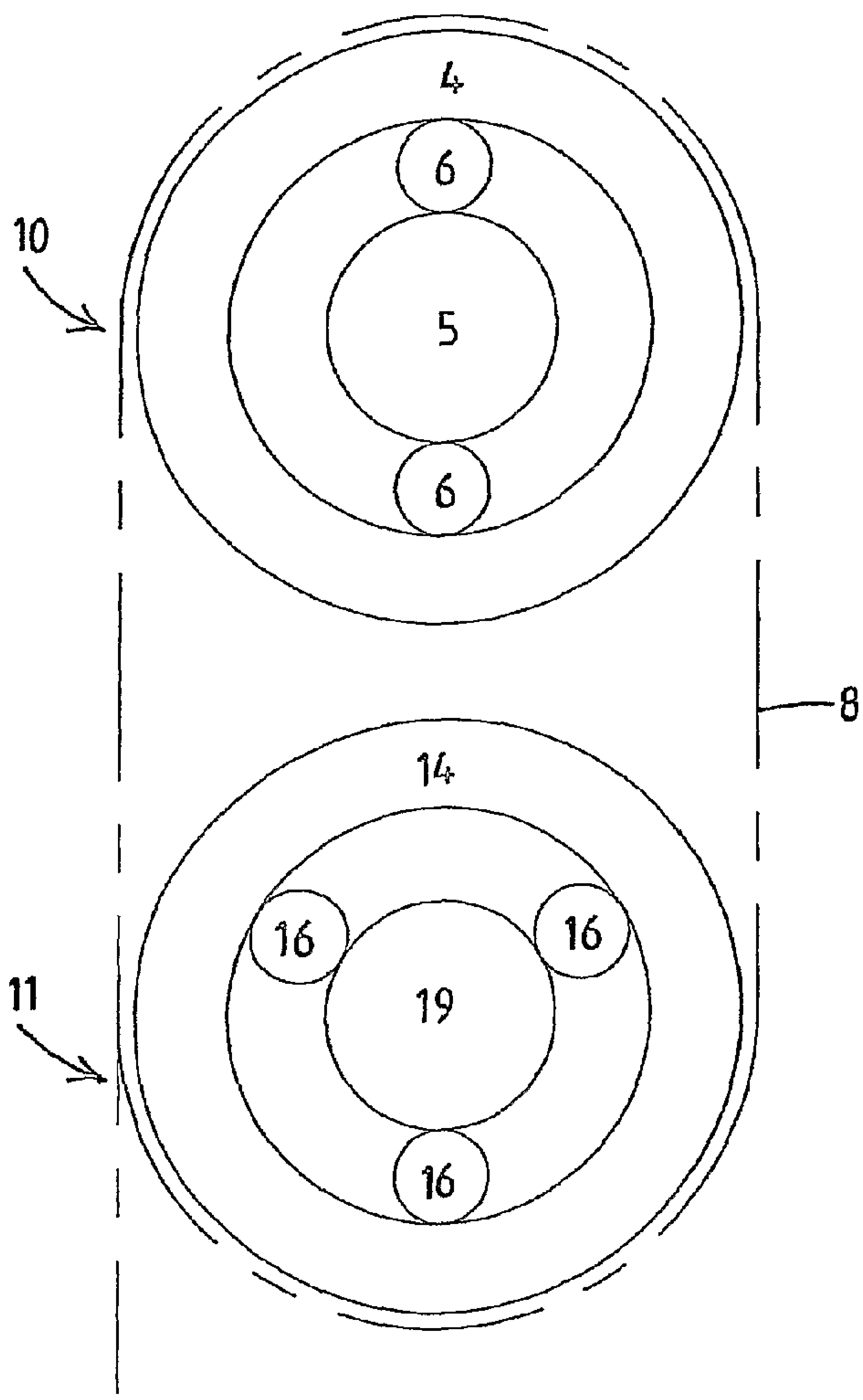

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Fig.1A

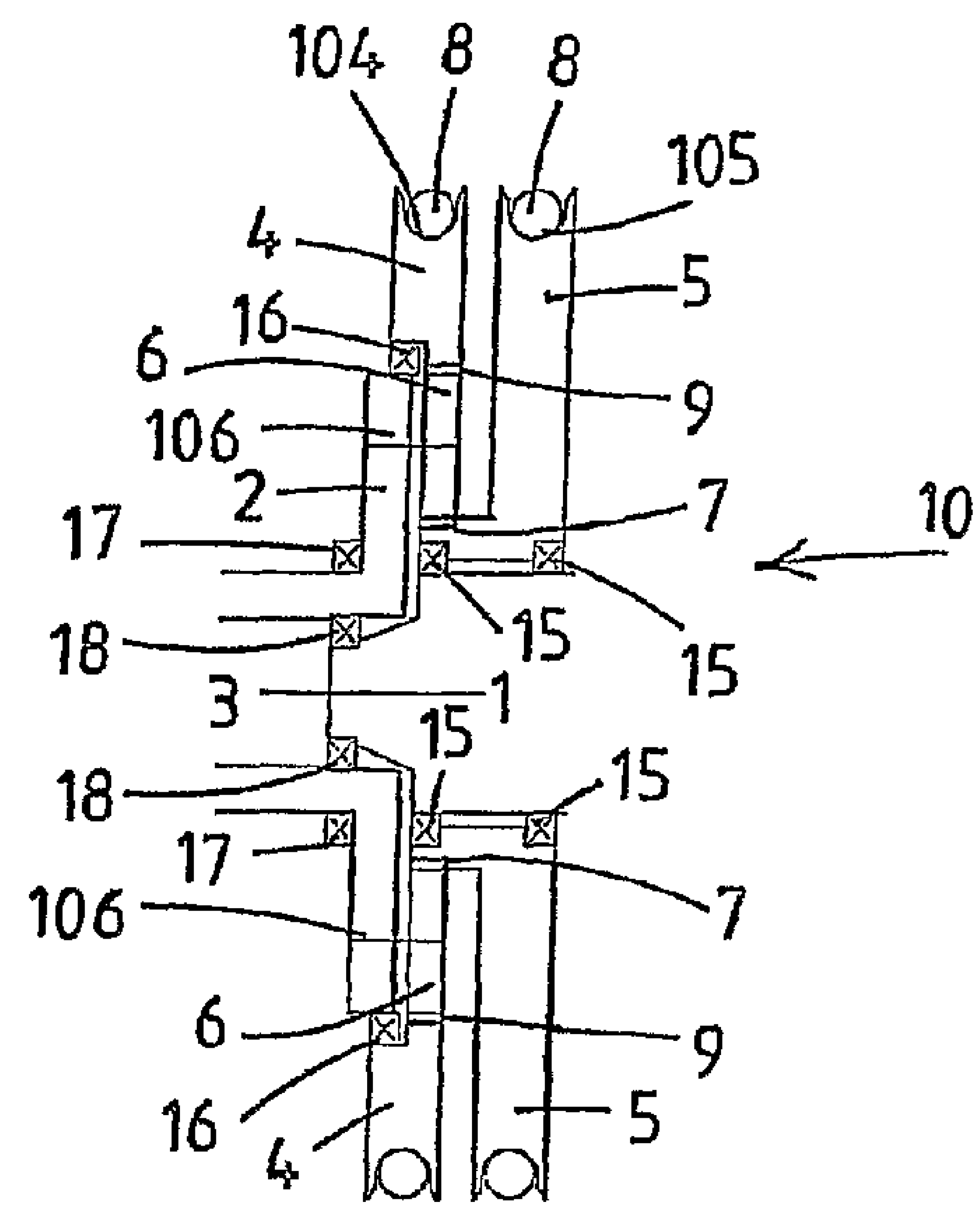
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Fig.1B

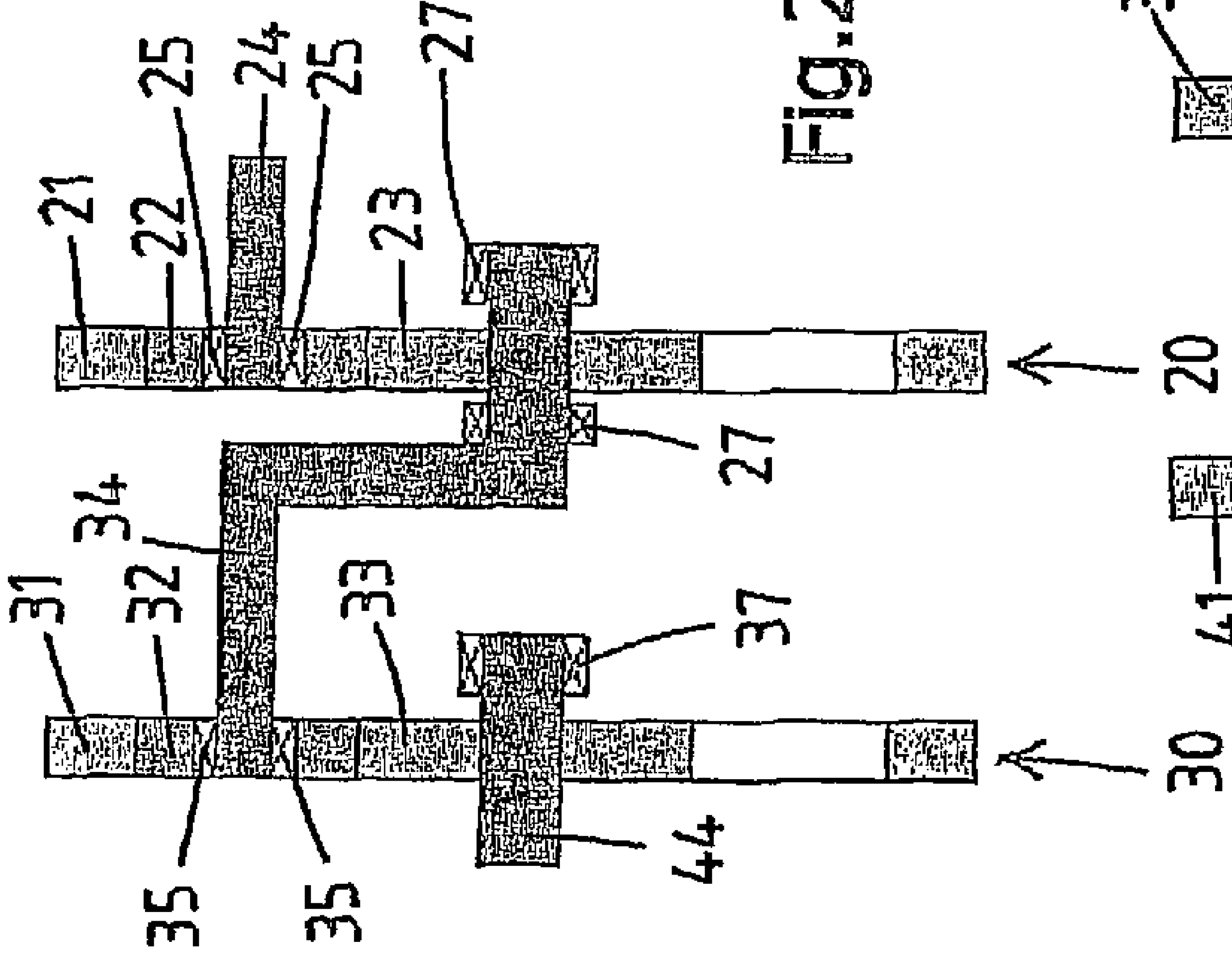

Fig.2B

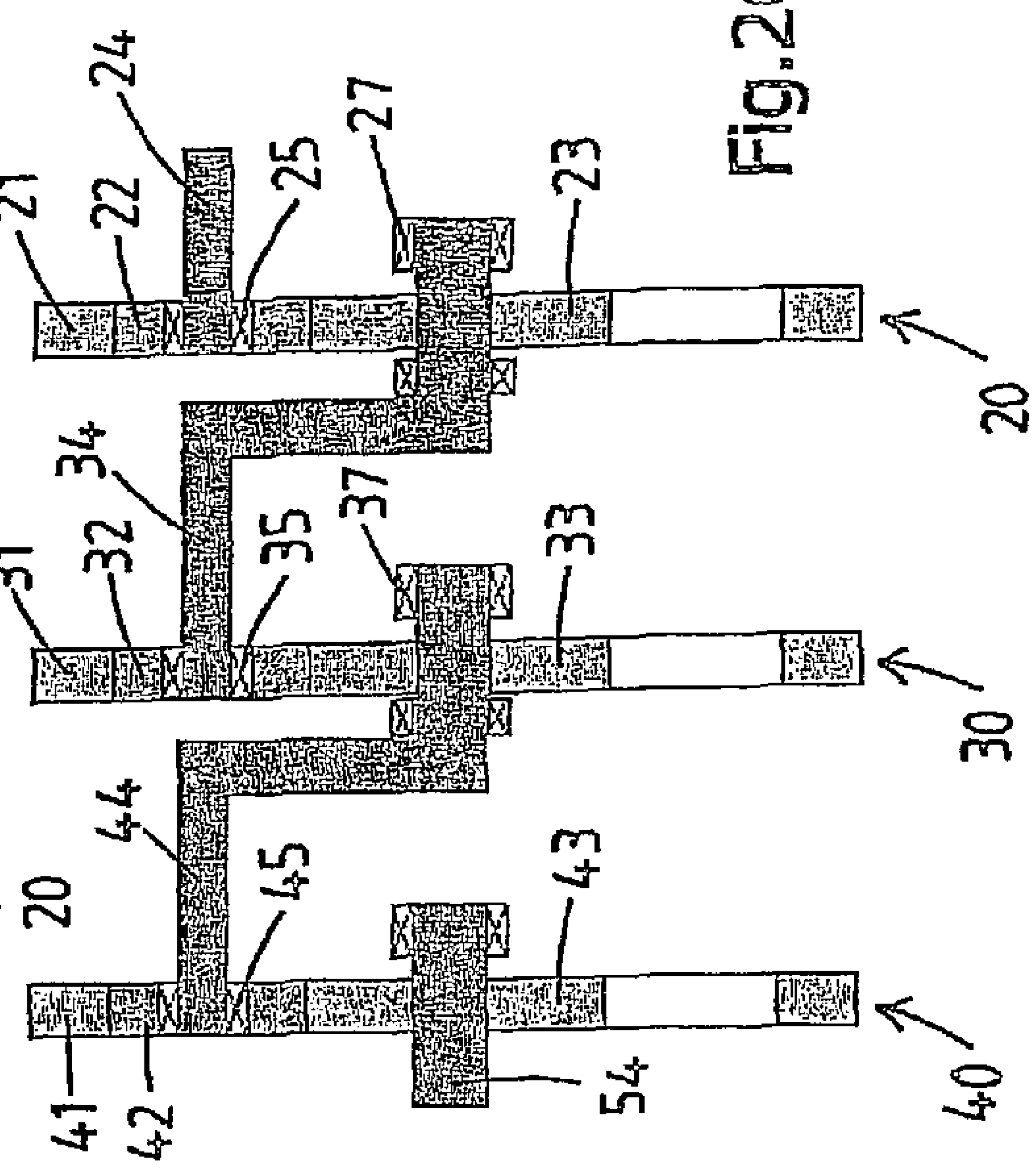

Fig.2C

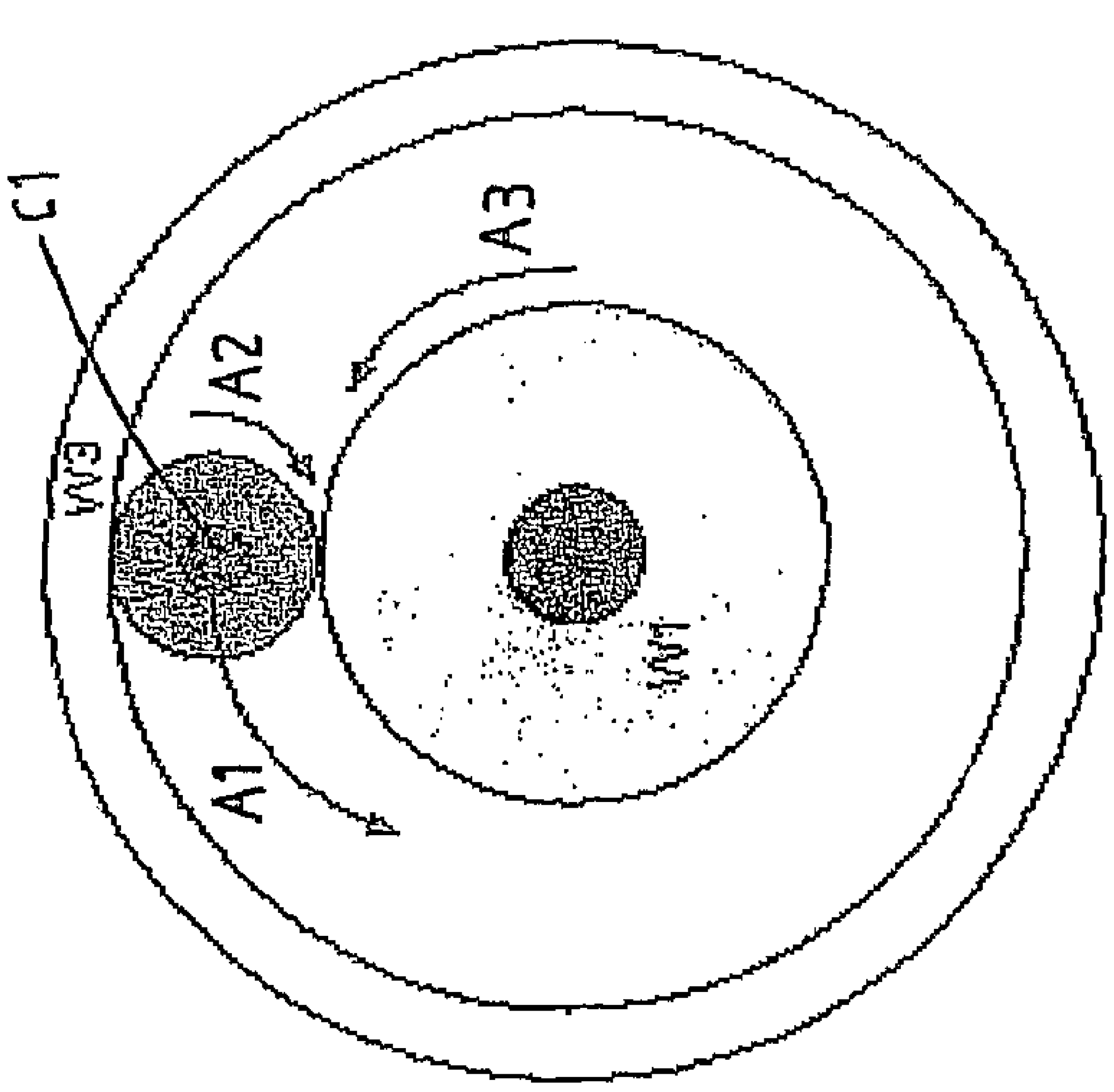

Fig.2A

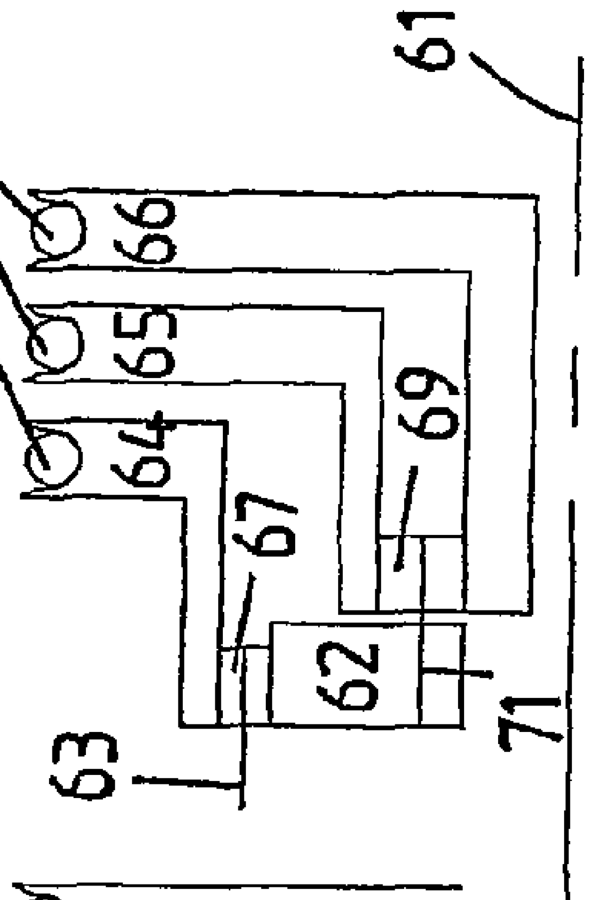

Fig.3C

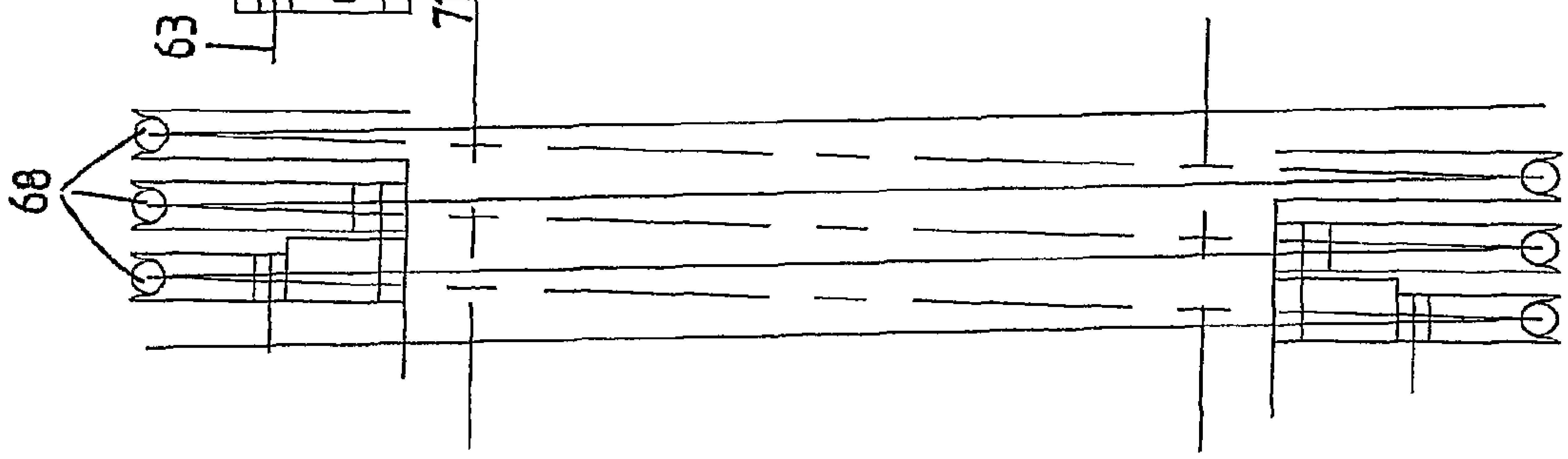

Fig.3B

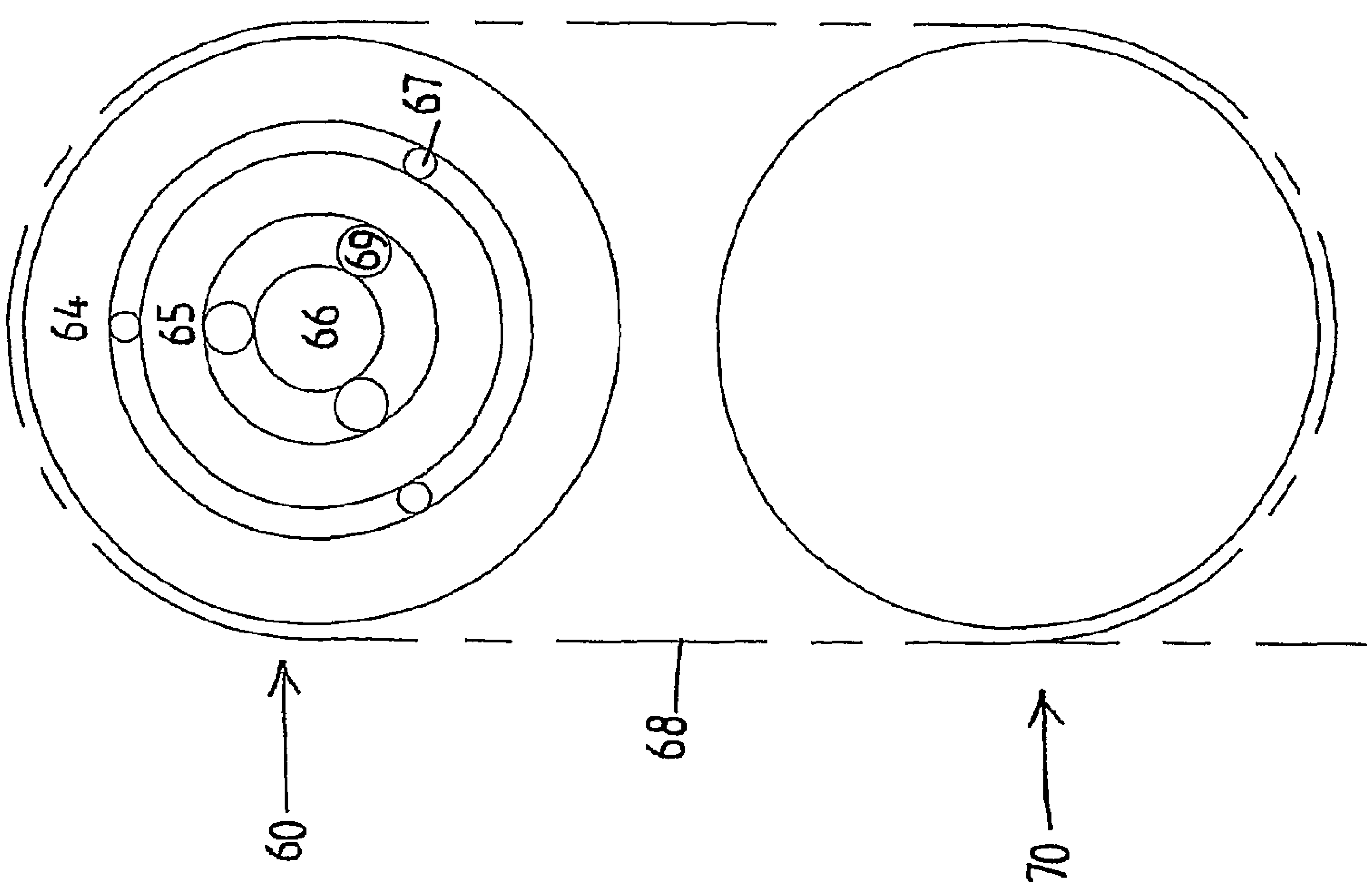

Fig.3A

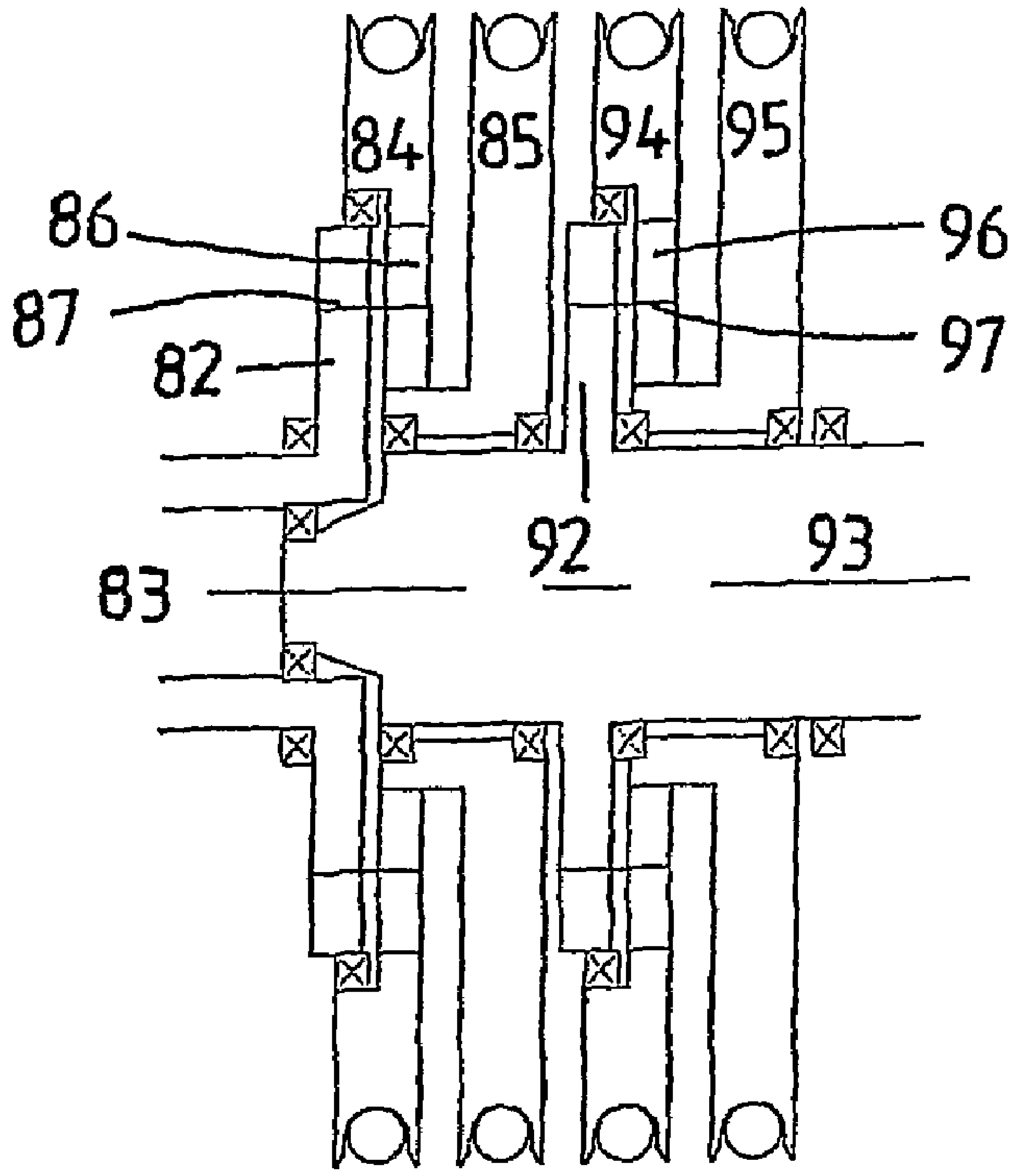

Fig.4

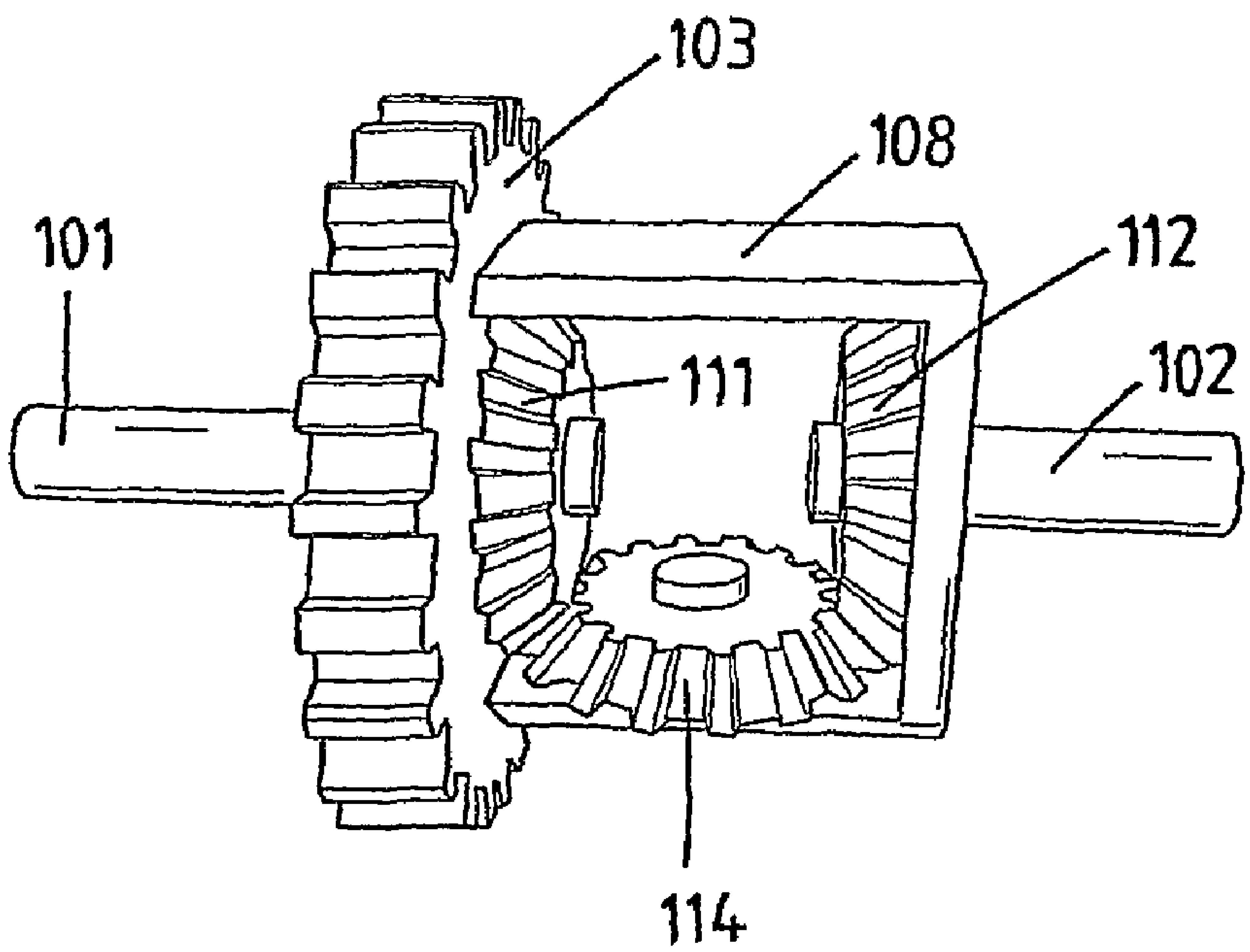

Fig.5

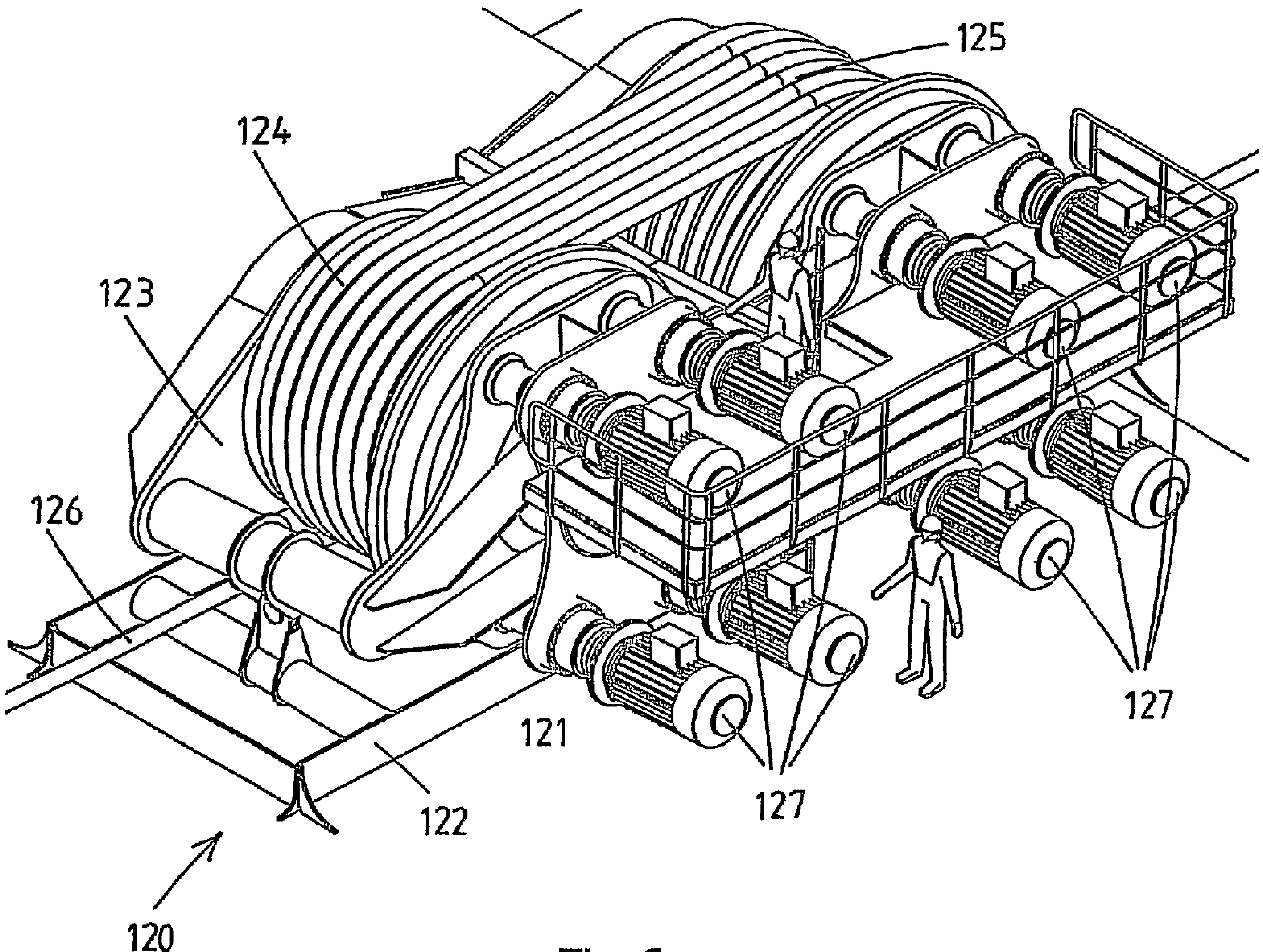

Fig.6

TRACTION WINCH

The present invention relates to a traction winch for a cable or the like, said winch comprising a winch frame, at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable, at least two rotatable driveshafts, journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly and at least one motor for driving the driveshafts.

Known winches of this kind are used for the retrieval of elongated bodies such as cables. In particularly, the invention relates to winches intended to haul very heavy loads by means of a cable, a not inconsiderable part of the load being often constituted by the weight of the cable, generally a cable of large diameter and of very great length. The invention also concerns the application of such a winch to off-shore technologies, e.g. for abandonment and recovery applications, oceanography and dredging at great depths. A problem of known traction winches is that cables wear rapidly. Under load fibre rope stretches which causes the cable to slip and the sheave to spin. This causes heat development which results in wear. This may be in particularly disadvantageous for high-tech cables.

In U.S. Pat. No. 6,182,915 a solution is presented according to which all sheaves are driven separately. In U.S. Pat. No. 7,175,163 an alternative solution is presented according to which the sheaves slip relatively with respect to a centrally provided drum.

It is an object of the present invention to provide yet an alternative traction winch which prevents slippage and wear of the cables over the sheaves upon elongation of the cable.

The winch of the invention includes a differential assembly being provided between each driveshaft and sheave assembly so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation.

Preferably, a differential gear assembly is provided. It is noted that other known differential assemblies are less preferred, but may also be applied.

The traction winch according to the invention is beneficial since it enables handling any type of rope, e.g. lightweight rope, fibre rope and cables in a very careful manner, without causing damage. The use of fibre rope is particularly beneficial when large ends are required, e.g. for use in deep water, because of its properties being as strong as steel wire but only a fraction of the weight. This means that lightweight fibre rope can handle a substantially better payload in deep water, and, due to its low weight, winches an handling equipment may be applied with much smaller power requirements and dimensions than for steel wire. As a result, energy and space consumption of traction winches on offshore equipment is reduced. Because of the differential assembly, slipping between rope and sheave is prevented which slipping develops heat and causes wear. Hence, it is possible to use lightweight rope in deep water, e.g. for lowering equipment and placing equipment on the bottom of the sea. The traction winch according to the invention enables an increase in lifting capacity, and hence lifting in increased water depths. The traction winch according to the invention may alternatively be applied for mooring purposes.

Preferred embodiments of the invention as well as the advantages and essential details thereof are disclosed in the drawing and the description and the claims which follow.

The invention will be explained in more detail with reference to the drawing, in which:

FIGS. **1***a* and **1***b* show schematic details of a first embodiment of a traction winch according to the invention;

FIGS. **2***a* and **2***b* show schematic details of a second embodiment of a traction winch according to the invention;

FIG. **2***c* shows a schematic detail of a third embodiment of a traction winch according to the invention;

FIGS. **3***a*-**3***c* show schematic details of a fourth embodiment of a traction winch according to the invention;

FIG. **4** shows a schematic detail of a fifth embodiment of a traction winch according to the invention;

FIG. **5** shows a schematic detail of a sixth embodiment of a traction winch according to the invention;

FIG. **6** shows a schematic perspective view of a traction winch according to the invention.

In FIG. **1** a traction winch according to the invention is partly shown. FIG. **1***a* is a schematical view of the operation of a differential gear assembly according to the invention, and FIG. **1***b* shows a cross-section of a differential gear assembly provided between a driveshaft and a sheave assembly.

In FIG. **1** a cable **8** is provided over two sheave assemblies **10**, **11**. Upper sheave assembly **10** is shown in cross section in FIG. **1***b*. The sheave assembly **10** comprises a first sheave **4** and a second sheave **5**, in the shown embodiment provided around a shaft **1**, which may be provided stationary. Each sheave **4**, **5** has a single circumferential friction surface **104**, **105** for the cable **8**. In analogy sheave assembly **11** comprises a first sheave **14** and a second sheave **19**, only part of which is shown in FIG. **1***a*. These sheaves **14**, **19** also have a single circumferential friction surface for the cable **8**.

A rotatable driveshaft **3** is associated with sheave assembly **10**. In analogy, a rotatable driveshaft (not shown) is associated with sheave assembly **11**. Both driveshafts are journalled in the winch frame in a side-by-side arrangement. At least one motor is provided for driving each of the driveshafts.

Between driveshaft **3** and sheave assembly **10** according to the invention a differential gear assembly is provided so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation.

In the preferred embodiment shown in FIG. **1**, the differential gear assembly is formed by the first sheave **4** being integral with a ring gear, the teeth of which are indicated by part **9**, and the second sheave **5** being integral with a central gear, the teeth of which are indicated by part **7**. Between the first sheave **4** (ring gear teeth **9**) and the second sheave **5** (central gear teeth **7**), and meshing therewith, are arranged two planetary gears **6**. In analogy, first sheave **14** of second sheave assembly **11** is formed integral with a ring gear and second sheave **19** is formed integral with a central gear, between which three planetary gears **16** are provided. Any other suitable number of planetary gears may be provided.

In the embodiment shown in FIG. **1***b*, the driveshaft **3** is provided with a carrier **2** which rotatably supports the two planetary gears **6** via axles **106**.

Bearings **15** are provided between sheave **5** and stationary shaft **1**, bearings **16** are provided between sheave **4** and carrier **2** and bearings **18** are provided between driveshaft **3** and shaft **1**. Bearings **17** next to carrier **2** are provided to fix the carrier **2**.

The operation of a planetary gear in a differential gear assembly is elucidated in FIG. **2***a*. Planetary gear W**2** is provided between, and meshing with, a ring gear W**3** and a central gear W**1**. Planetary gear W**2** is rotatable within the track defined between W**1** and W**2**, indicated by arrow A**1**, by moving its central axis C**1**. This rotation may e.g. be performed by a carrier such as carrier **2** shown in FIG. **1***b*, connected to an axle in central axis C**1**. Planetary gear W**2** is also rotatable about its own central axis C**1** as indicated by arrow A2. Without any resistance of W1 or W3, or with infinite resistance between W2 and its central axis C1, rotation of planetary gear W2 in the direction A1 will cause all gears W1, W2 and W3 to rotate with the same angular velocity. When, e.g., W3 is suspected to any resistance, W2 will start to roll over W3 and rotate about its central axis C1 in the direction of arrow A2. This causes W1 to rotate in the direction A3 relative to W3, resulting in a rotational speed difference between W1 and W3.

In the embodiment shown in FIG. **1**, first sheave **4** is integral with a ring gear similar to W3, and second sheave **5** is integral with a central gear similar to W1. Planetary gears **6** resemble W2. When for example a wire enters sheave **4** with a length of 1 m, it may elongate e.g. to 1.5 m due to tension increase over the sheave **1**. So the first sheave **4** has to rotate to move 1 m and the second sheave **5** has to rotate to move 1.5 m. So sheave **5** needs to rotate faster, which is accomplished by the differential gear assembly comprising the planetary gears **6**, which cause meshing central gear **5** to have a larger rotational speed than meshing ring gear **4**.

In FIG. **2***b* a slightly different operating differential gear assembly is indicated. This differential gear assembly comprises two similar gear sets **20**,**30** of a ring gear **21**,**31**, planetary gear **22**,**32** and central gear **23**,**33**. Planetary gears **22**, **32** are rotatable about their central axis via bearings **25**, **35**. Axle **24** of planetary gear **22** is driven, e.g. by a carrier (not shown). This causes ring gear **21** and central gear **23** to rotate. A sheave (not shown) may be coupled to, or formed integral with first ring gear **21**. Axle **34** of planetary gear **32** is driven by the rotational movement of central gear **23**. Axle **34** is fixed in the central axis of central gear **23** and supported by bearings **27**.

Driving planetary gear **32** causes ring gear **31** and central gear **33** to rotate. A second sheave (not shown) may be coupled to, or formed integral with second ring gear **31**. The shown differential gear assembly allows for different rotational speeds of the ring gears **21**, **31**, and hence of the connected or integral sheaves (not shown).

A third axle **44** is shown in bearing **37**, connected to central gear **33**. These features are redundant in case only two sheaves are provided in the sheave assembly. A third sheave may be connected to the shown axle **44** of the second central gear **33**, operating similar to sheave **5** shown in FIG. **1***b*. This is in fact the situation shown in FIG. **3**.

In FIG. **2***c* the same differential gear assembly principle as shown in FIG. **2***b* is continues with a third gear set **40** similar to gear sets **20**,**30** comprising a ring gear **41** to which a third sheave may be connected or integrally formed with, a planetary gear **42** and central gear **43**. Planetary gear **42** is rotatable via bearings **45** and axle **44**, which axle **44** is connected with central gear **33** of second gear set **30**. The gear assembly may be even further continued with the installation of a fourth gear set coupled to axle **54** connected with central gear **43** of third gear set **40**, and likewise be continued.

Yet an alternative differential gear assembly is shown in FIG. **3**. In FIG. **3***a* a cable **68** is provided over two sheave assemblies **60**, **70**. Upper sheave assembly **60** is shown in side view in FIG. **3***b* and schematically in FIG. **3***c*. Lower sheave assembly **70** is not elucidated further but is of identical design. The sheave assembly **60** comprises a first sheave **64**, second sheave **65**, and third sheave **66**, in the shown embodiment provided around a central axis **61**. Each sheave **64**, **65**, **66** has a single circumferential friction surface for the cable **68**.

In the embodiment shown in FIG. **3**, the differential gear assembly is formed by the first sheave **64** being integral with a first ring gear, the second sheave **65** being integral with a second ring gear, and third sheave **66** being integral with a second central gear. Between first ring gear **64** and first central gear **62**, and meshing therewith, are three first planetary gears **67** arranged. Between second ring gear **65** and second central gear **66**, and meshing therewith, are three second planetary gears **69** arranged. A carrier (not shown) may rotatably support the three first planetary gears **67** via axles **63**. Second planetary gears **69** are driven by first central gear **62** via axles **71** in the central axis of the planetary gears **69**.

An alternative embodiment is shown in FIG. **4**. A traction winch according to the invention may comprise four sheave assemblies arranged in pairs, and four driveshafts arranged in pairs, each pair on a common axis. Between each driveshaft and associated sheave assembly a differential gear assembly is provided, which is shown in FIG. **4**. Driveshaft **83** rotates carrier **82** which drives planetary gear **86** via axle **87**. Planetary gear **86** drives first sheave **84** and second sheave **85**, analogous to the operation shown in FIG. **1***b*. The shaft **93** in FIG. **4** is a second driveshaft, which rotates carrier **92** which in turn drives planetary gear **96** via axle **97**. Planetary gear **96** drives third sheave **94** and fourth sheave **95**.

The principle of yet an alternative a differential gear assembly is shown in FIG. **5**. A traction winch for a cable according to the invention comprises a winch frame and at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable. Upon assembly, the first and second sheave are connected to shown axles **101**, **102**. Rotatable drive gear **103** is journalled in the winch frame and driven by a motor. A carrier **108** integral with rotatable drive gear **103** drives primary gear **111** and secondary gear **112** which are connected to the first and second sheave (not shown) via axles **101** and **102**. A planetary gear **114** is provided between primary gear **101***a* and secondary gear **102***a* so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation.

In FIG. **6** a traction winch **120** is schematically shown. Traction winch **120** is provided on a deck **121** on a frame **122**. The shown winch **120** comprises a winch frame **122**, **123** and at least two sheave assemblies **124**, **125**, each having at multiple sheaves having circumferential friction surfaces for cable **126**. Two rotatable driveshafts (not visible per se) are journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly **124**, **125**. Four motors **127** are provided for driving each driveshaft, driving the driveshaft via a gear assembly (not shown).

1	shaft
2	carrier
3	driveshaft
4	first sheave
5	second sheave
6	planetary gear
7	teeth of central gear
8	cable
9	teeth of ring gear
10	sheave assembly
11	sheave assembly
14	first sheave
15	bearing
16	bearing
17	bearing
18	bearing
19	second sheave
20	gear set
21	ring gear
22	planetary gear

-continued

23	central gear
24	axle
25	bearing
30	gear set
31	ring gear
32	planetary gear
33	central gear
34	axle
35	bearing
40	gear set
41	ring gear
42	planetary gear
43	central gear
44	axle
45	bearing
54	axle
60	sheave assembly
61	central axis
62	central gear
63	axle
64	first sheave
65	second sheave
66	third sheave
67	planetary gear
68	cable
69	planetary gear
70	sheave assembly
71	axle
82	carrier
83	driveshaft
84	first sheave
85	second sheave
86	planetary gear
87	axle
92	carrier
93	shaft
94	third sheave
95	fourth sheave
96	planetary gear
97	axle
101	axle
102	axle
103	drive gear
104	circumferential friction surface
105	circumferential friction surface
106	axle
111	primary gear
112	secondary gear
114	planetary gear
120	traction winch
121	deck
122	frame
123	frame
124	sheave assembly
125	sheave assembly
126	cable
127	motors
W1	central gear
W2	planetary gear
W3	ring gear
A1	arrow
A2	arrow
A3	arrow
C1	central axis

The invention claimed is:

1. A traction winch for a cable or the like, said winch comprising:

a winch frame;

at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable;

at least two rotatable driveshafts, journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly;

at least one motor for driving the driveshafts; and

a differential gear assembly being provided between each driveshaft and sheave assembly so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation,

wherein the differential gear assembly is formed by a ring gear and a central gear and at least one planetary gear being arranged between the ring gear and the central gear and meshing therewith, wherein the first sheave is integral with the ring gear, and the second sheave is integral with the central gear.

2. The traction winch according to claim **1**, wherein the at least two drive shafts are provided with a carrier rotatably supporting the at least one planetary gear.

3. The traction winch according to claim **2**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

4. The traction winch according to claim **2**, wherein all driveshafts present are driven by a separate motor.

5. The traction winch according to claim **1**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

6. The traction winch according to claim **1**, wherein all driveshafts present are driven by a separate motor.

7. A traction winch for a cable or the like, said winch comprising:

a winch frame;

at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable;

at least two rotatable driveshafts, journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly;

at least one motor for driving the driveshafts; and

a differential gear assembly being provided between each driveshaft and sheave assembly so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation,

wherein the differential gear assembly is formed by a primary and secondary gear and at least one planetary gear being arranged between the primary gear and the secondary gear and meshing therewith, wherein the first sheave is connected to the primary gear and the second sheave is connected to the secondary gear.

8. The traction winch according to claim **7**, wherein the at least two drive shafts are provided with a carrier rotatably supporting the at least one planetary gear.

9. The traction winch according to claim **7**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

10. The traction winch according to claim **7**, wherein all driveshafts present are driven by a separate motor.

11. A traction winch for a cable or the like, said winch comprising:

a winch frame;

at least two sheave assemblies each having at least a first sheave and a second sheave, each sheave having a single circumferential friction surface for the cable;

at least two rotatable driveshafts, journalled in the winch frame in a side-by-side arrangement, each drive shaft being associated with a sheave assembly;

at least one motor for driving the driveshafts; and

a differential gear assembly being provided between each driveshaft and sheave assembly so as to allow for different rotational speeds of the sheaves during operation of the traction winch due to cable elongation,

wherein the differential gear assembly is formed by:

the first sheave being integral with a first ring gear;

the second sheave being integral with a second ring gear;

a first central gear;

a second central gear;

at least one first planetary gear being arranged between the first ring gear and the first central gear and meshing therewith; and

at least one second planetary gear being arranged between the second ring gear and the second central gear and meshing therewith, which second planetary gear is supported by a second carrier connected to the first central gear.

12. The traction winch according to claim **11**, in which the sheave assemblies are provided with a third sheave being integral with the second central gear.

13. The traction winch according to claim **12**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

14. The traction winch according to claim **12**, wherein all driveshafts present are driven by a separate motor.

15. The traction winch according to claim **11**, in which the sheave assemblies are provided with a third sheave, and the differential gear assembly is further formed by:

the third sheave being integral with a third ring gear,

a third central gear,

at least one third planetary gear being arranged between the third ring gear and the third central gear and meshing therewith, which third planetary gear is supported by a third carrier connected to the second central gear.

16. The traction winch according to claim **15**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

17. The traction winch according to claim **15**, wherein all driveshafts present are driven by a separate motor.

18. The traction winch according to claim **11**, wherein the traction winch comprises four sheave assemblies arranged in pairs, and wherein the traction winch has four driveshafts arranged in pairs, each pair on a common axis, and wherein between each driveshaft and associated sheave assembly a differential gear assembly is provided.

19. The traction winch according to claim **11**, wherein all driveshafts present are driven by a separate motor.

* * * * *